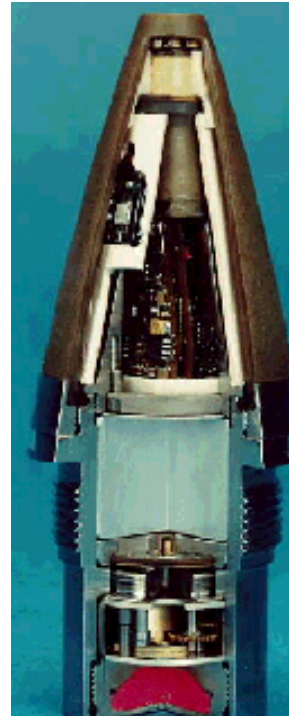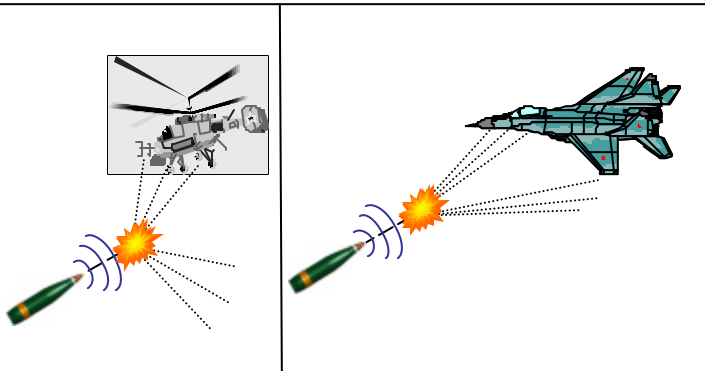# First Article Test Results
&
Subsequent Design Changes
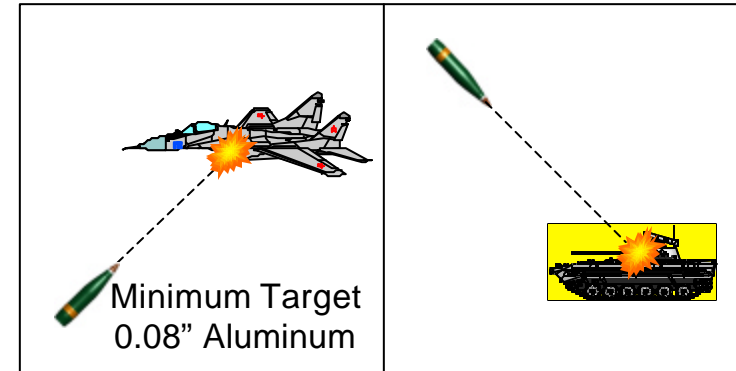
John Richardson

NSWC Dahlgren Division

G34, Fuze Branch

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Air Proximity (AIR)

Point Detonating (PD)

Minimum Target
0.08" Aluminum
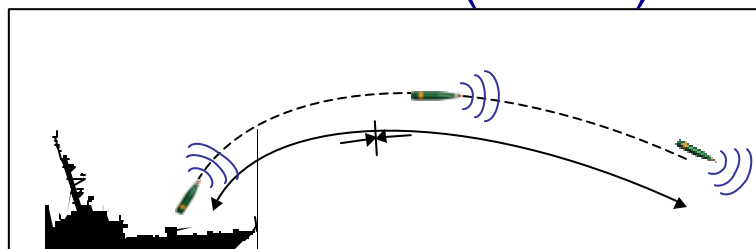
Surface Proximity (HOB)
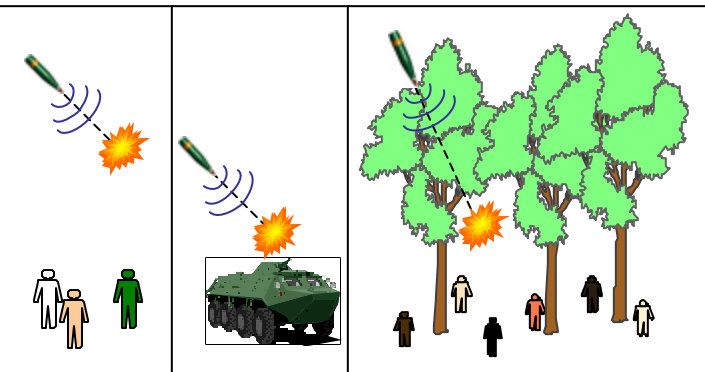
Electronic Time (ET)
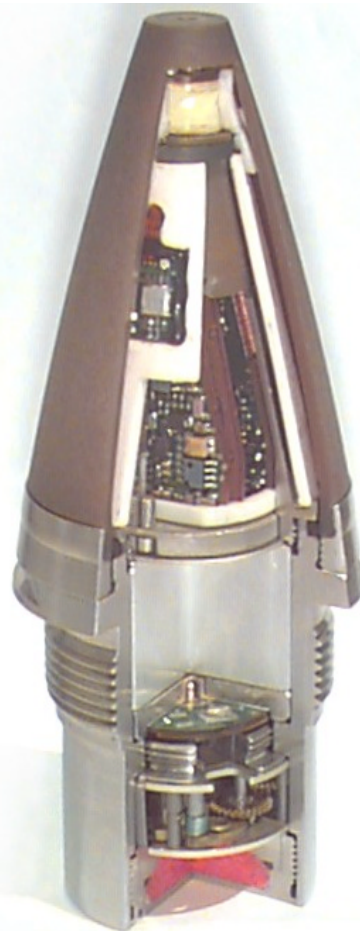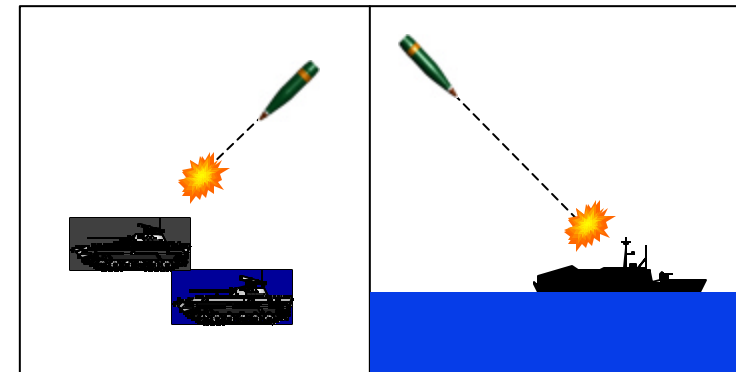
Replaces VT, CVT,
MT and PD fuzes
on HE rounds.
Simplifies logistics.
Uses IM Explosives

Autonomous (AUTO)

Multiplies effectivenes
of ship's magazine.
Improves fuze
performance, accurac
and versatility

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- 14% Dud Rate

- Low Height of Burst (HOB) over Land

- Air Mode early bursts

Telemetry indicated S&As didn't arm

Failure analysis found:

– **Excessive booster assembly torque caused:**

- Rotor to bottom plate interference
- S&A gear pivots binding on booster assembly
- Additional similar problems

– **Contributing factor: Loctite on booster threads acted as lubricant increasing axial load to torque ratio**

Corrective action: Reduce torque on booster during installation

S&A

Booster

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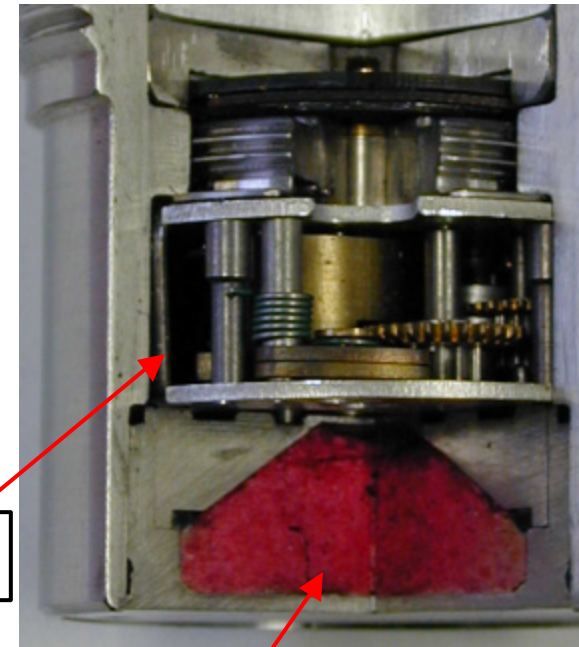
- For fuzes set to detonate at 65'
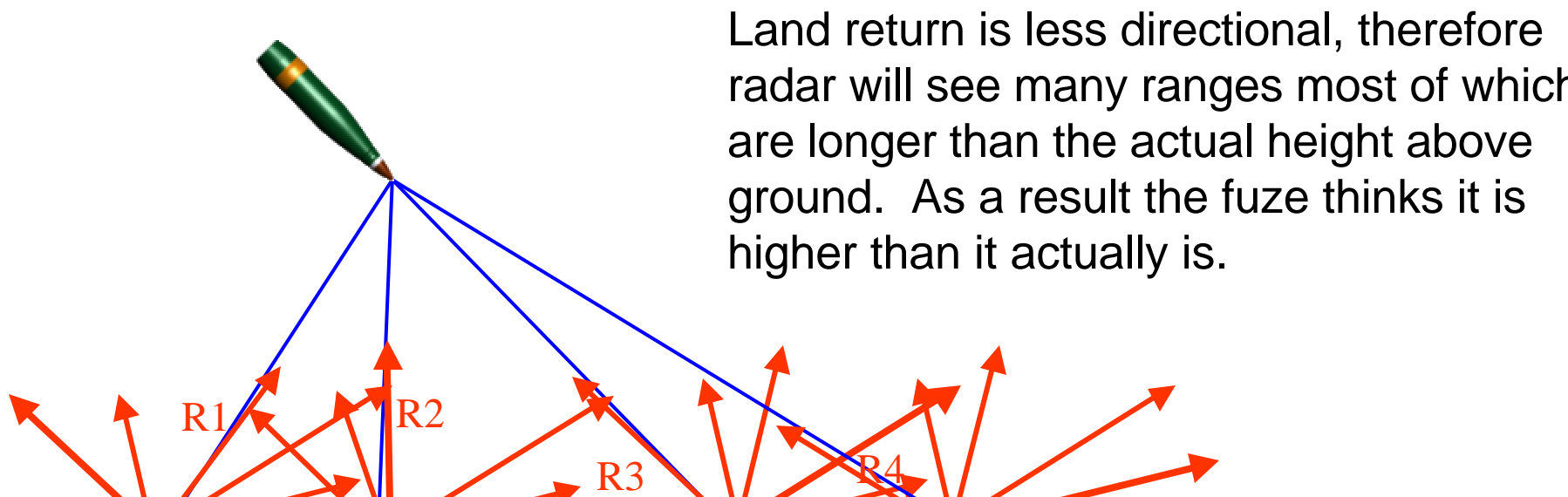 - Actual mean HOB over water was 63'
  - Actual mean HOB over desert was 54'
  - Bias is approx 10' low over land

- Alliant Tech (prime contractor) generated an RF model to help understand problem

Water return is more directional, therefore radar will see fewer ranges and 'measured' height will be close to the correct height.

R2

water

Land return is less directional, therefore radar will see many ranges most of which are longer than the actual height above ground. As a result the fuze thinks it is higher than it actually is.

R1   R2

R3

R4
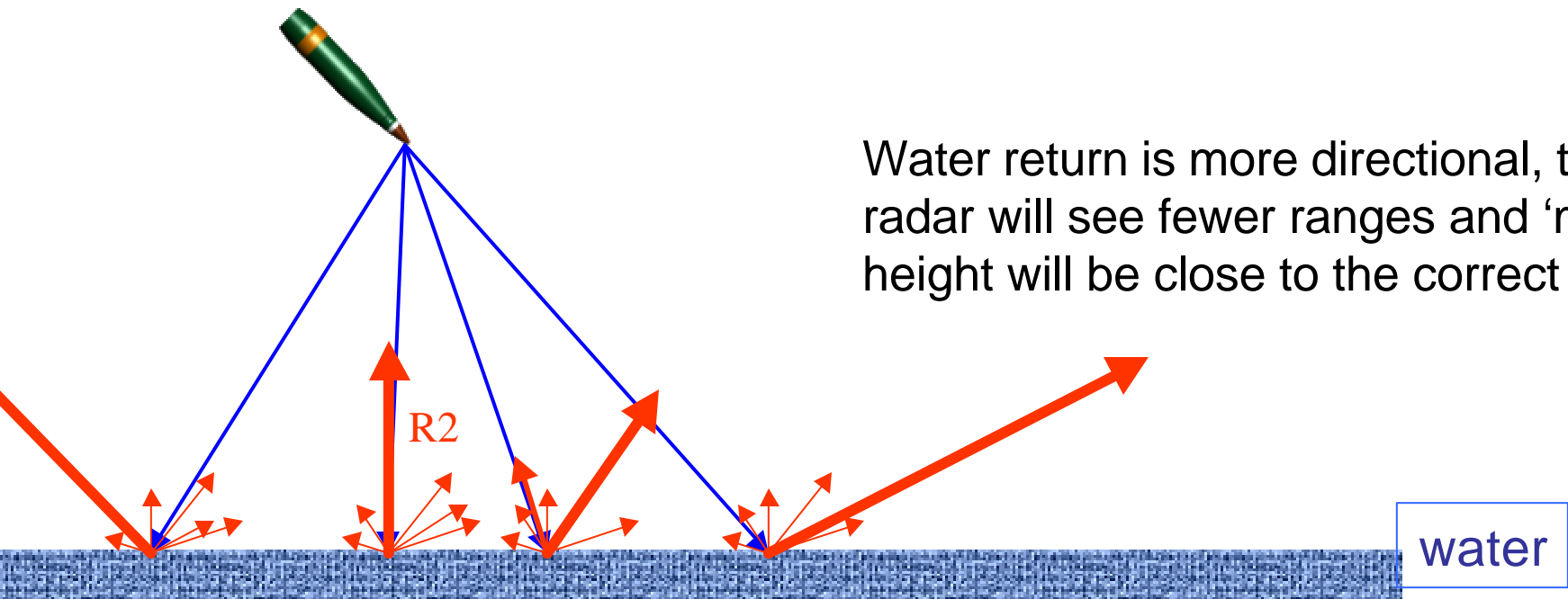
100 x 100 grid of individual cells

Useful for investigating HOB and AIR mode clutter problems
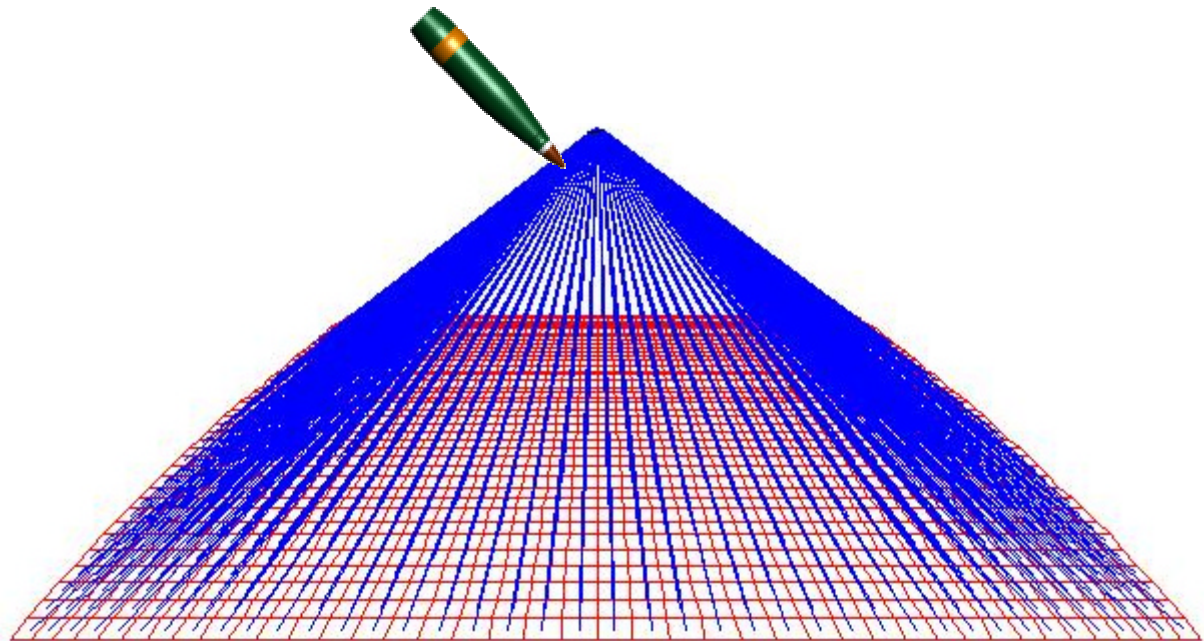
Surface Matrix

- Integrate the Return from Each Clutter Cell

$$v(t) = \sum_{Pitch}\sum_{Roll} \sqrt{\frac{P_{xmt}\,G_{xmt}\,G_{rcv}\,l^2\,G_{conv}\,G_{proc}\,H^2\!\left(f_{dop}\right)\!\left(J2 - J4\right)^2 \mathbf{s}_0\,Area}{\left(4\mathbf{p}\right)^3 R^4}} \cos\!\left(2\mathbf{p}f_{dop}t\right)$$

Note the strong return from cells that are not directly below the fuze for the sand surface. The summation of signals from multiple frequencies results in constructive and destructive interference.

Clutter Reflectivity in Log Scale vs. Position On the Surface

Surface

Surface

Sand

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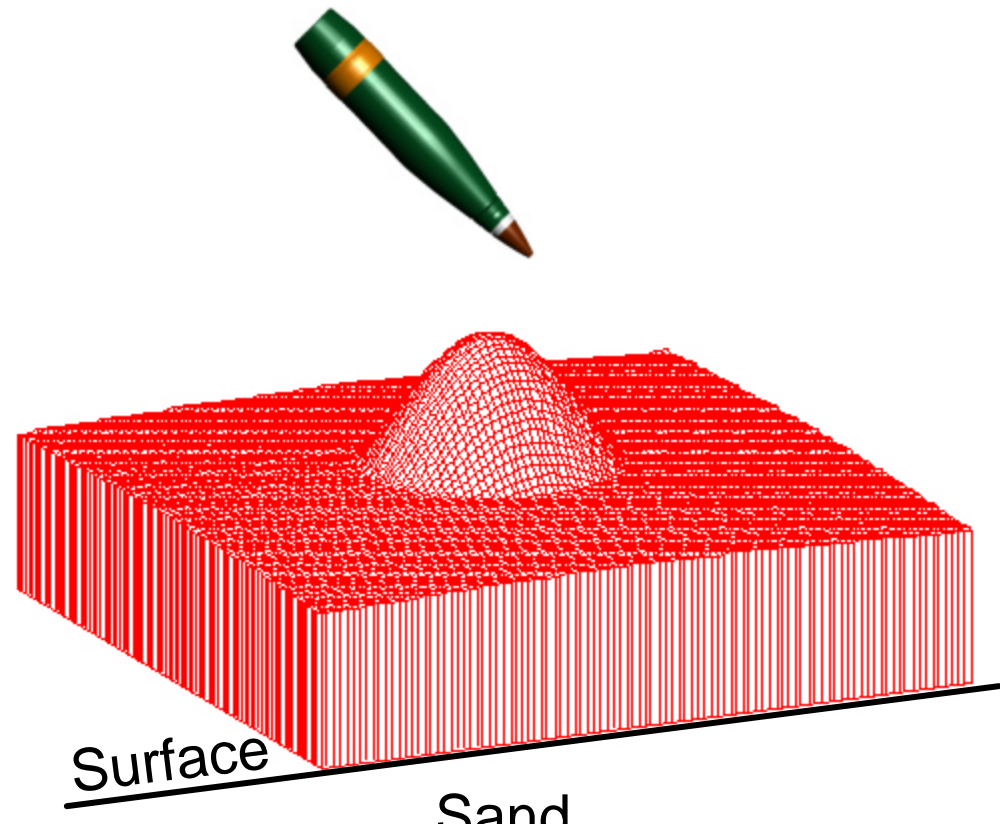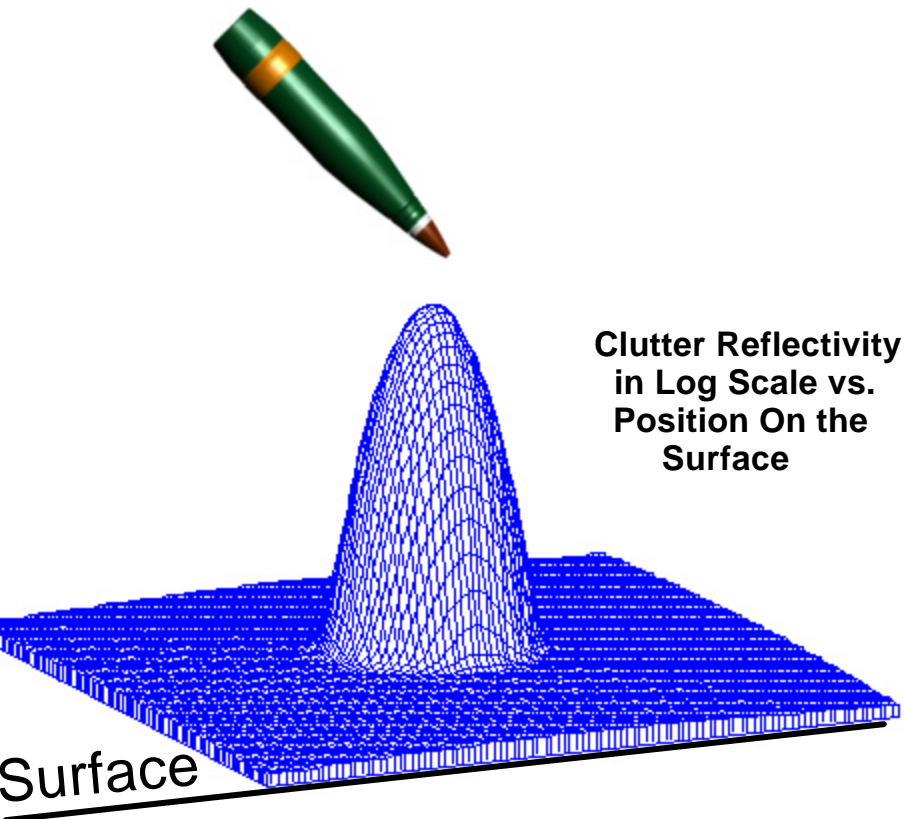
MFF uses the harmonics of the Doppler return from the surface to detect a reference height

MFF then measures the rate of descent and computes the time to reach the desired HOB

- Heights as low as 90 feet below a canopy surface can be selected

No RF Solution Found

– Use of multiple Doppler harmonics will compensate for varying target strength but not for the multiple ranges associated with a real surface

Software Approach Taken

– The software assumes the reference height is 10 feet lower than the RF indicates
– HOB over calm water will be approx 8' high
– HOB over land will be approx 1' low

10' Bias in Software Rational

– HOB accuracy over land is more important than over water
– Rougher water should lower the HOB over water further

- Problem: Low elevation angle trajectories, with early RF turn-on times caused detonations on clutter when testing over land.

- Concern: When engaging low over the water air targets the fuze may detonate on sea clutter before reaching the target.

Sphere
Target
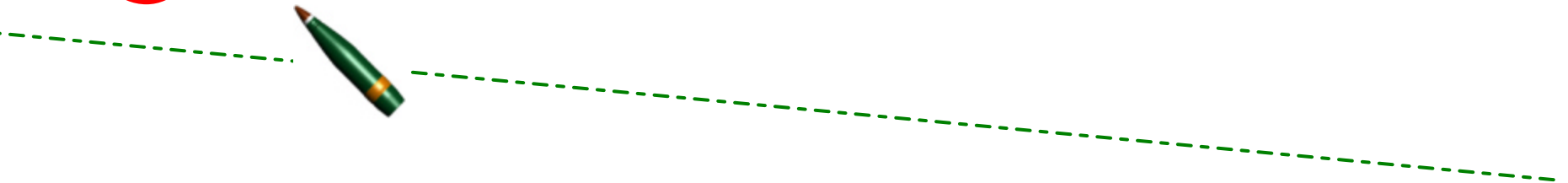
- Not a bad problem
  - The RF model (a previous slide) indicated that since land clutter was more omni-directional it presented a worse problem compared to sea clutter than anticipated
  - At sea tests confirmed that sea clutter was not a major problem
- Improvement
  - The clutter filter was changed to make it more robust
    - Old approach might have marginally passed without change

- S&A arm problem can be solved by reducing booster installation torque
- Low HOB bias over land
    - Compromise adjustment made so HOB over land is low and HOB over water is high
- Air mode clutter rejection filter adjusted to eliminate potential problem

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- Validation testing summer 2002
  - Sea tests to verify clutter filter improvements and HOB over water
  - Land based testing for other modes

- First Article testing winter 2002
  - Land based testing of all modes